

**What is claimed is:**

1. A map displaying apparatus that displays a map, comprising:  
a map data storing unit operable to store map data;  
a sound data obtaining unit operable to obtain sound data; and  
5 an image generating unit operable to generate map drawing data based on the map data stored in the map data storing unit and the sound data obtained from the sound data obtaining unit.
2. A map displaying apparatus according to Claim 1,  
10 wherein the map data is data relating to at least one three-dimensional object, and  
the image generating unit changes one of a shape and a position of the at least one three-dimensional object in accordance with changes in the sound data.
- 15 3. A map displaying apparatus according to Claim 2,  
wherein the shape is changed by changing a height of the at least one three-dimensional object.
- 20 4. A map displaying apparatus according to Claim 3,  
wherein the image generating unit includes:  
an object generating unit operable to fetch the map data stored in the map data storing unit, specify local coordinates of vertices of the at least one three-dimensional object, and carry out a generating  
25 process for the at least one three-dimensional object;  
a local coordinate transformation matrix changing unit operable to fetch the sound data from the sound data fetching unit and change, using the sound data, a local coordinate transformation matrix for transforming the local coordinates to global coordinates;  
30 a local coordinate transforming unit operable to transform the local coordinates of the vertices of the at least one three-dimensional object to global coordinates using the matrix changed by the local

coordinate transformation matrix changing unit;

a model view transforming unit operable to specify viewpoint coordinates for a viewpoint in the global coordinates, and generate the map drawing data by transforming the global coordinates to a coordinate system centered on the viewpoint coordinates using a model view transformation matrix.

5 5. A map displaying apparatus according to Claim 4,  
wherein the local coordinate transformation matrix is a four-row,  
10 four-column transformation matrix, and

the local coordinate transformation matrix changing unit changes a value of a second row, second column element in the local coordinate transformation matrix based on the sound data.

15 6. A map displaying apparatus according to Claim 1,  
wherein the map data is data relating to three-dimensional objects, and

the image generating unit changes color data applied to the at least one three-dimensional object based on changes in the sound data.

20 7. A map displaying apparatus according to Claim 6,  
wherein the image generating unit includes  
an object generating unit operable to fetch map data stored in  
25 the map data storing unit, to specify local coordinates of vertices of the at least one three-dimensional object, and carry out a generation process for the at least one three-dimensional object;

an object coloring changing unit operable to obtain color data of the at least one three-dimensional object stored in the map data storing unit and change the color data based on changes in the sound data obtained from the sound data obtaining unit;

30 a local coordinate transforming unit operable to set a local

coordinate transformation matrix for transforming the local coordinates to global coordinates and transform the local coordinates to global coordinates using the local coordinate transformation matrix; and

5           a model view transforming unit operable to specify viewpoint coordinates for a viewpoint in the global coordinates, and generate the map drawing data by transforming the global coordinates to a coordinate system centered on the viewpoint coordinates using a model view transformation matrix.

10           8.       A map displaying apparatus according to Claim 7,  
              wherein the object coloring changing unit obtains (a) color data of top vertices of the at least one three-dimensional object, and (b) color data of base vertices of the at least one three-dimensional object  
15           from the map data storing unit, and changes the color data of at least one of (a) and (b) based on the sound data obtained from the sound data obtaining unit.

              9.       A map displaying apparatus according to Claim 8,  
20           wherein the object coloring changing unit carries out a gradation process for a color of the top vertices and a color of the base vertices of the at least one three-dimensional object after changing to change intermediate color data of the at least one three-dimensional object.

25           10.       A map displaying apparatus according to Claim 1,  
              wherein the map data is data relating to at least one three-dimensional object, and  
              the image generating unit changes a display region for the at  
30           least one three-dimensional object on a screen based on changes in the sound data.

11. A map displaying apparatus according to Claim 10,  
wherein the image generating unit includes:

a three-dimensional display region setting unit operable to set  
the display region for the at least one three-dimensional object based  
5 on changes in the sound data obtained from the sound data obtaining  
unit;

an object generating unit operable to fetch map data stored in  
the map data storing unit for the three-dimensional display region set  
by the three-dimensional display region setting unit, specify local  
10 coordinates of vertices of the at least one three-dimensional object,  
and carry out a generation process for the at least one  
three-dimensional object, and to not fetch map data stored in the map  
data storing unit nor carry out a generation process for  
three-dimensional objects for a non-three dimensional display region  
15 set by the three-dimensional display region setting unit;

a local coordinate transforming unit operable to set a local  
coordinate transformation matrix for transforming the local  
coordinates to global coordinates and transform the local coordinates  
to global coordinates using the local coordinate transformation matrix;  
20 and

a model view transforming unit operable to specify viewpoint  
coordinates for a viewpoint in the global coordinates and generate the  
map drawing data by transforming the global coordinates to a  
coordinate system centered on the viewpoint coordinates using a  
25 model view transformation matrix.

12. A map displaying apparatus according to Claim 11,

wherein the three-dimensional display region setting unit  
divides the three-dimensional display region into two in one of an  
30 up-down direction and a left-right direction of the screen and sets one  
divided part as the three-dimensional display region and another  
divided part as the non-three-dimensional display region

13. A map displaying apparatus according to Claim 1,  
wherein the map data is data relating to at least one  
three-dimensional object, and

5 the image generating unit carries out a process that shakes top  
vertices of the at least one three-dimensional object based on changes  
in the sound data.

14. A map displaying apparatus according to Claim 13,  
10 wherein the image generating unit includes:

an object generating unit operable to fetch the map data stored  
in the map data storing unit, specify local coordinates of vertices of the  
at least one three-dimensional object, and carry out a generating  
process for the at least one three-dimensional object;

15 a local coordinate transforming unit operable to set a local  
coordinate transformation matrix for transforming the local  
coordinates to global coordinates and transform the local coordinates  
to global coordinates using the local coordinate transformation matrix;

a model view transforming unit operable to specify viewpoint  
20 coordinates for a viewpoint in the global coordinates and transform the  
global coordinates to a coordinate system centered on the viewpoint  
coordinates using a model view transformation matrix; and

a coordinate changing unit operable to obtain the sound data  
from the sound data inputting unit and generate the map drawing data  
25 by carrying out a process that changes a matrix transformed by the  
model view transforming unit based on changes in the sound data.

15. A map displaying apparatus according to Claim 14,

wherein the coordinate changing unit carries out a process that  
30 translates all top vertices of the at least one three-dimensional object  
in a certain direction.

16. A map displaying apparatus according to Claim 14,  
wherein the matrix transformed by the model view transforming  
unit is a four-row, four-column matrix, and  
the coordinate changing unit changes a second row, third  
5 column element of the matrix based on changes in the sound data.

17. A map displaying apparatus according to Claim 1,  
wherein the map data is data relating to mesh data forming at  
least one mountain object, and  
10 the image generating unit changes color data relating to colors  
of a mesh included in the mesh data based on changes in the sound  
data.

18. A map displaying apparatus according to Claim 17,  
15 wherein the image generating unit includes:  
a color data changing unit operable to change the color data  
included in the mesh data forming the at least one mountain object  
based on changes in the sound data obtained from the sound data  
obtaining unit;

20 an object generating unit operable to specify local coordinates  
of vertices of the at least one mountain object using the mesh data  
including the color data changed by the color data changing unit and  
carry out a generation process for the at least one mountain object;

a local coordinate transforming unit operable to set a local  
25 coordinate transformation matrix for transforming the local  
coordinates to global coordinates and transform the local coordinates  
to global coordinates using the local coordinate transformation matrix;  
and

a model view transforming unit operable to specify viewpoint  
30 coordinates for a viewpoint in the global coordinates and generate the  
map drawing day by transforming the global coordinates to a  
coordinate system centered on the viewpoint coordinates using a

model view transformation matrix;

19. A map displaying apparatus according to Claim 18,  
wherein the color data changing unit changes the color data  
5 included in the mesh data from a summit side of the at least one  
mountain object.

20. A map displaying apparatus according to Claim 17,  
wherein the mesh data includes altitude data composed of  
10 heights above points in a lattice oriented with longitude and latitude  
directions to express undulations in a land surface, shape data of the  
mesh, and color data of the mesh.

21. A map displaying apparatus according to Claim 1,  
15 wherein the image generating unit includes a region division  
unit operable to divide a region of a screen based on frequency bands  
of the sound data obtained from the sound data obtaining unit, and  
generates the map drawing data separately for each region produced  
by division by the region division unit.

20 22. A map displaying apparatus according to any of Claim 1 to Claim  
21,

wherein the image generating unit includes:

25 a projection matrix changing unit operable to change a  
projection transformation matrix for projecting the at least one  
three-dimensional object onto two-dimensional coordinates based on  
sound data obtained from the sound data obtaining unit; and

a projection transforming unit operable to project and transform  
a matrix after model view transformation using the projection  
30 transformation matrix changed by the projection matrix changing unit.

23. A map displaying apparatus according to Claim 1,

wherein the sound data includes at least one of data relating to magnitudes of sounds and data relating to magnitudes of sounds in respective frequency bands.

5    24.    A map displaying method for displaying a map, comprising:  
         a map data storing step of storing map data;  
         a sound data obtaining step of obtaining sound data; and  
         an image generating step of generating map drawing data based  
         on the map data stored in the map data storing step and the sound  
10   data obtained in the sound data obtaining step.

         25.    A program for a map displaying apparatus that displays a map,  
         comprising:  
         a map data storing step of storing map data;  
15           a sound data obtaining step of obtaining sound data; and  
         an image generating step of generating map drawing data based  
         on the map data stored in the map data storing step and the sound  
         data obtained in the sound data obtaining step.